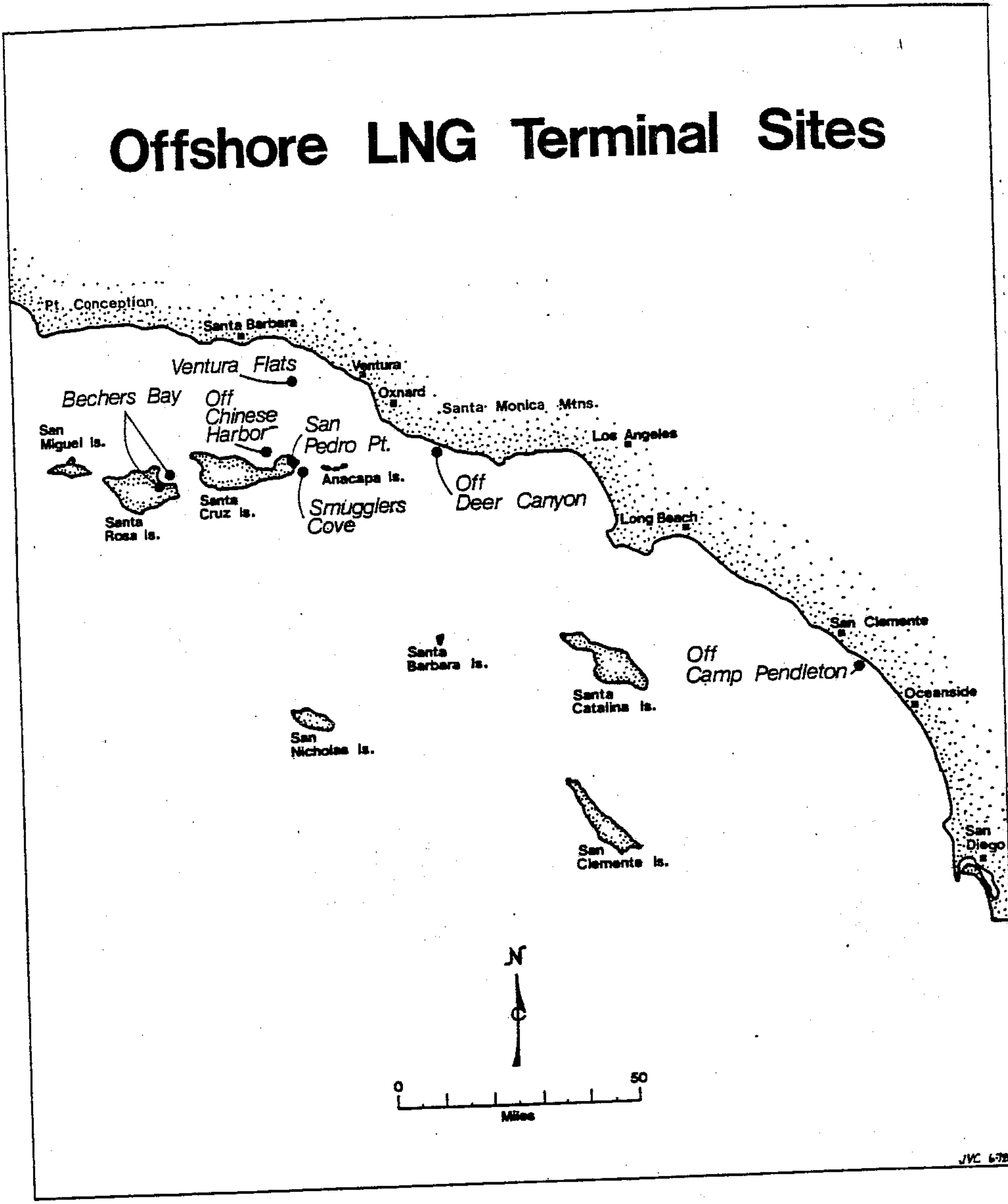
Offshore LNG Terminal Sites
Pt. Conception
Santa Barbara
Ventura Flats
Ventura
Oxnard
Santa Monica Mtns.
Los Angeles
Bechers Bay
Off Chinese Harbor
San Pedro Pt.
San Miguel Is.
Santa Rosa Is.
Santa Cruz Is.
Anacapa Is.
Smugglers Cove
Off Deer Canyon
Long Beach
San Clemente
Off Camp Pendleton
Oceanside
Santa Barbara Is.
Santa Catalina Is.
San Nicholas Is.
San Clemente Is.
San Diego
N
0
50
Miles
JVC 6-78

Figure 3

Types of Bottom Supported Offshore LNG Terminals

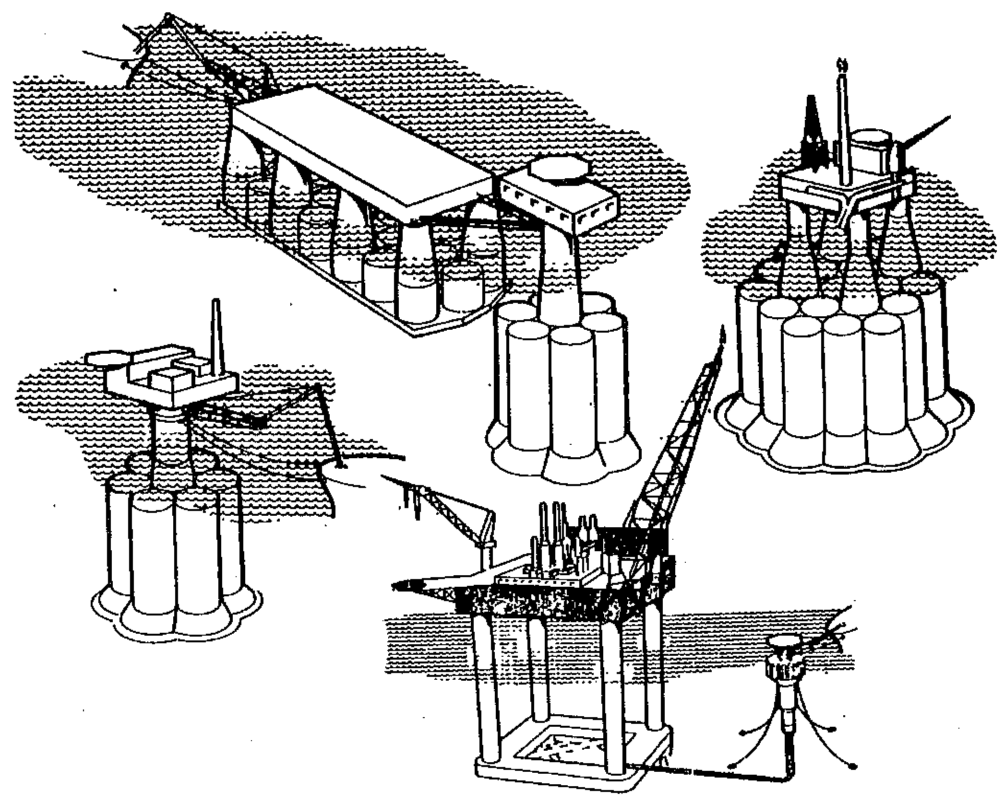

Figure 4

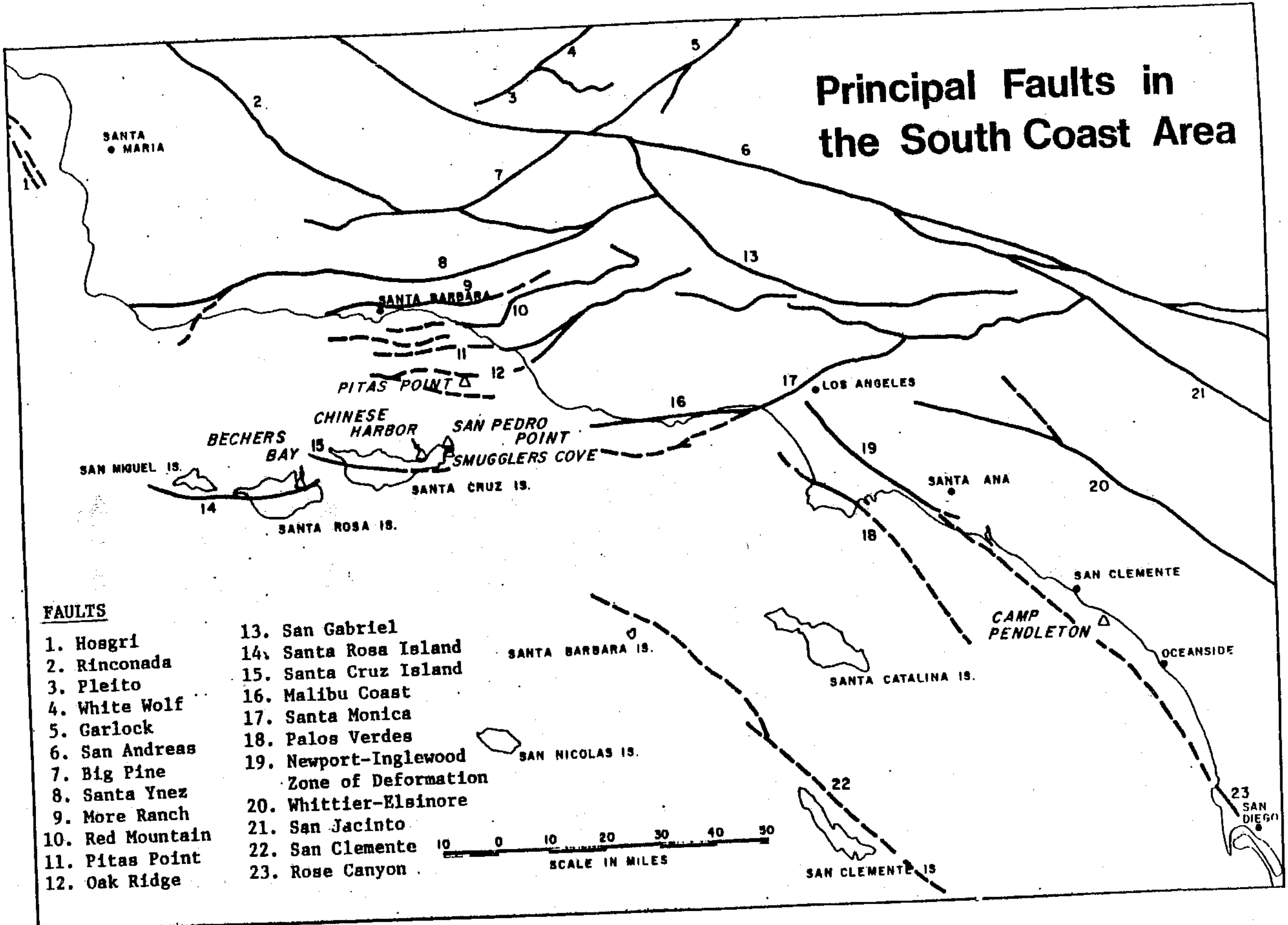
Principal Faults in the South Coast Area
SANTA MARIA
SANTA BARBARA
PITAS POINT
CHINESE HARBOR
SAN PEDRO POINT
SMUGGLERS COVE
BECHERS BAY
SAN MIGUEL IS.
SANTA ROSA IS.
SANTA CRUZ IS.
LOS ANGELES
SANTA ANA
SAN CLEMENTE
CAMP PENDLETON
OCEANSIDE
SAN DIEGO
SANTA BARBARA IS.
SANTA CATALINA IS.
SAN NICOLAS IS.
SAN CLEMENTE IS.
10 0 10 20 30 40 50
SCALE IN MILES
FAULTS
1. Hosgri
2. Rinconada
3. Pleito
4. White Wolf
5. Garlock
6. San Andreas
7. Big Pine
8. Santa Ynez
9. More Ranch
10. Red Mountain
11. Pitas Point
12. Oak Ridge
13. San Gabriel
14. Santa Rosa Island
15. Santa Cruz Island
16. Malibu Coast
17. Santa Monica
18. Palos Verdes
19. Newport-Inglewood Zone of Deformation
20. Whittier-Elsinore
21. San Jacinto
22. San Clemente
23. Rose Canyon

Figure 5

The evaluations provide moderate confidence that a bottom-supported terminal could safely and reliably be built on a part of the northwest section of Ventura Flats and off Camp Pendleton. Even there much more evaluation would be needed, and there would be the serious uncertainty of discovery of added faults anytime during the permitting process or during terminal operation. Thus the major advantage of a floating terminal over other onshore or offshore terminals is that only the base of the mooring system, and not other critical components, is susceptible to significant earthquake forces.[1]

Site Evaluations

The site evaluations show many other factors that make the seven sites other than southeast Ventura Flats less appropriate or unacceptable. The major factors in the evaluations are listed in Table 1. They include (1) confidence in the feasibility of terminal and pipeline construction and in reliable tanker berthing and pipeline operation, (2) public safety, (3) conflicts with recreation, petroleum development and military uses of offshore areas, (4) adverse impacts on marine and coastal resources, (5) cost, and (6) the time it could take to put a terminal into operation. A summary of these evaluations is presented in Table 1.

Ventura Flats. The southeast portion of Ventura Flats, centered 12 miles west of Port Hueneme and eight miles from the nearest land, is judged the most appropriate site. Of the terminal types evaluated, a floating terminal is definitely appropriate for the site and a subsea bottom-supported terminal may be appropriate if the sea bottom can be shown to provide a secure foundation for such a tall, massive structure.

Either a floating or subsea bottom-supported terminal would be feasible but less appropriate on the northwest part of Ventura Flats. The area has already been leased to oil companies by the Interior Department and there may be an oil field there, the underwater gas pipeline to shore would have to cross over the Pitas Point earthquake fault, and the route for the pipeline onshore would be especially damaging to environmental resources since it must traverse coastal and interior canyons (Figure 1).

Offshore Deer Canyon. A floating terminal about one mile off Deer Canyon (Figure 6) would also be feasible but less appropriate because it would intrude on the recreational experience at popular Leo Carillo and Point Mugu State Parks and at the coastal part of the Santa Monica Mountains, which are proposed for national park status. It seems unlikely that the public safety aspects of such a terminal would be acceptable. It would be about 5 miles from the Point Mugu Naval Pacific Missile Test Center and the homes of northern Malibu, while within 4 miles are heavily used parks, children's camps, and the Pacific Coast

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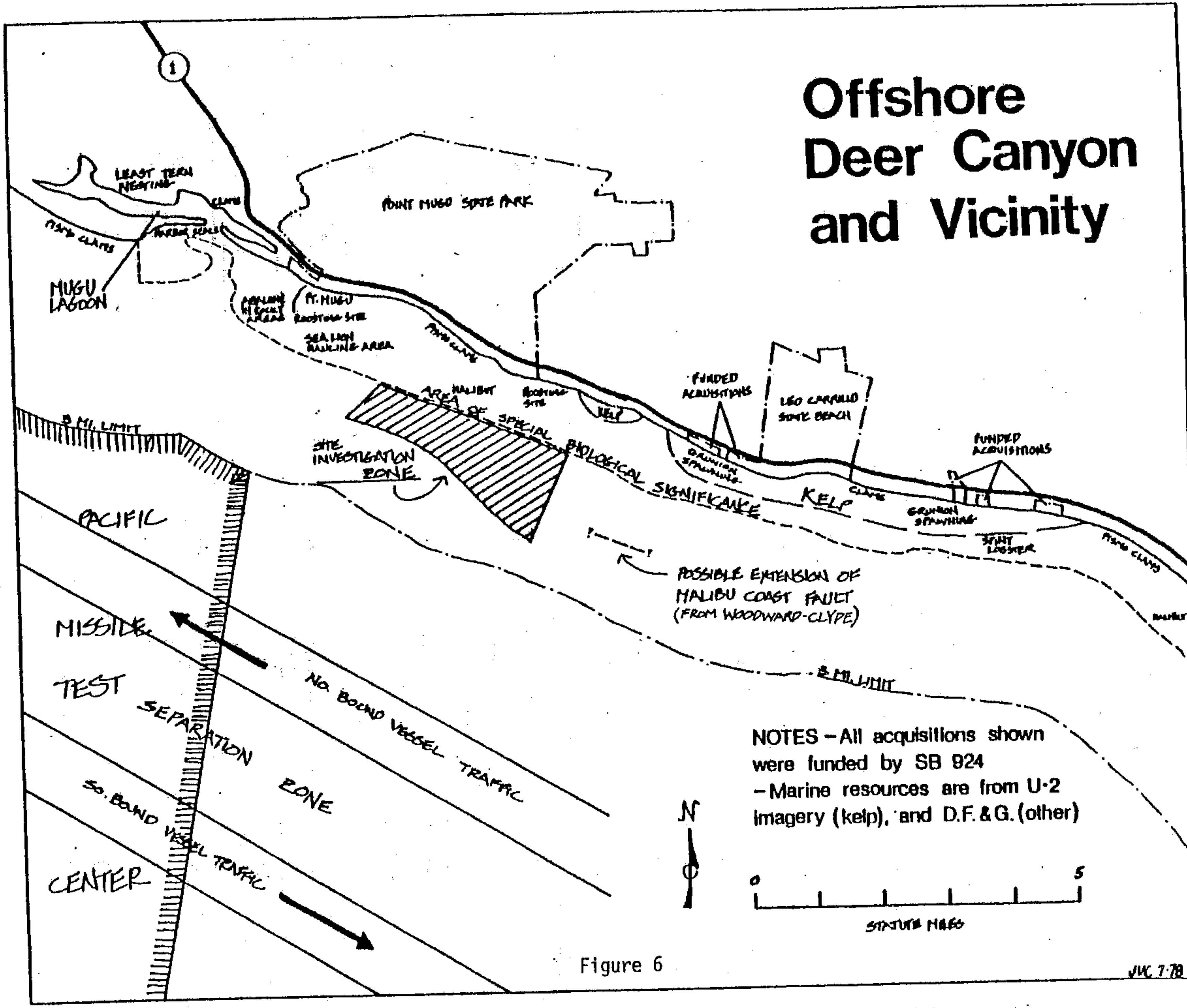
1 Vertical earthquake forces are transmitted to floating structures but are estimated to be considerably smaller than the wave slamming forces for which such structures are routinely designed. Horizontal earthquake forces are "decoupled" from floating, flexibly moored structures.



Offshore Deer Canyon and Vicinity
POINT MUGU STATE PARK
LEAST TERN NESTING
PISMO CLAMS
HARBOR SEALS
MUGU LAGOON
PT. MUGU ROOSTING SITE
SEA LION HAULING AREA
PISMO CLAMS
HALIBUT
ROOSTING SITE
KELP
AREA OF SPECIAL BIOLOGICAL SIGNIFICANCE
FUNDED ACQUISITIONS
LEO CARRILLO STATE BEACH
GRUNION SPAWNING
KELP
CLAMS
FUNDED ACQUISITIONS
GRUNION SPAWNING
SPINY LOBSTER
PISMO CLAMS
3 MI. LIMIT
SITE INVESTIGATION ZONE
POSSIBLE EXTENSION OF MALIBU COAST FAULT (FROM WOODWARD-CLYDE)
3 MI. LIMIT
PACIFIC MISSILE TEST CENTER
SEPARATION ZONE
NO. BOUND VESSEL TRAFFIC
SO. BOUND VESSEL TRAFFIC
NOTES – All acquisitions shown were funded by SB 924
– Marine resources are from U-2 imagery (kelp), and D.F.&G. (other)
N
0
5
STATUTE MILES
JVC 7-78

Figure 6

'ABLE 1: Summary of Site Evaluations

	Ventura Flats SE		Ventura Flats NW		Off Deer Canyon	Off Camp Pendleton	
	Floating	Subsea	Floating	Subsea	Floating	Floating	Shallow Bottom
Confidence in Construction Feasibility With Respect to Geotechnical (Mainly Seismic) Factors							
--Terminal	High	Low	High	Medium	High	High	Medium
--Pipeline	High	High	High	High	Low	High	High
Confidence in Reliability of Operations							
--Berthing (weather)	92%	96%	92%	96%	97%	98%	94%
--Pipeline (seismic)	High	High	Medium	Medium	High	High	High
Public Safety							
--Distance to nearest 1,000 people	12 mi	12 mi	9 mi	9 mi	4-6 mi	7 mi	5.5 mi
--Activity nearby (3 mi)	Sparse	Sparse	Sparse	Sparse	Moderate	Intense	Intense
--Critical facilities	None	None	None	None	Pt. Mugu, 4 mi	San Onofre Nuclear Power Plant, 4 mi	
Use Conflicts							
--Recreational conflicts	None	None	None	None	Substantial	Moderate	Substantial
--Petroleum leases	None	Leased	Leased	Leased	Partly	None	None
--Military conflicts	None	None	None	None	Small	Substantial	
Adverse Marine and Coastal Resource Impacts							
--Fishing	Moderate		Moderate		Moderate	Small	Small
--Special species	Some disturbance		Some disturbance		Some dis.	Small	Small
--Compatibility	Acceptable		Acceptable		Very poor	Poor	Poor
--Construction	Small	Small	Small	Small	Small	Small	Substantial
--Onshore pipeline	Small	Small	Severe	Severe	Substantial	Small	Small
Cost, ± 20% (1977-78 dollars)	$489m	$552m	$507m	$570m	$454m	$414m	$431m
Timing to Operation							
--Minimum time to operation	6-7 yr	7-8 yr	6-7 yr	7-8 yr	6½ yr	6½ yr	8 yr
--Likely opposition	Moderate		Substantial		Severe	Extreme	Extreme
Preliminary Overall Judgment	Most appropriate	Appropriate if feasible	Less appropriate	Less appropriate	Less appropriate	Less appropriate	Less appropriate

☐ Box represents serious constraint

Off Chinese Harbor		Off Smugglers Cove		On San Pedro Point	Off Bechers Bay		Onshore Bechers Bay
Floating	Subsea	Floating	Shallow Bottom		Floating	Shallow Bottom	
High	Low	High	Low	Low	High	Low	Low
Probable, but not demonstrated					Questionable		
96%	97%	97%	96%	96%	94%	95%	95%
Medium	Medium	Medium	Medium	Medium	Low	Low	Low
24 mi	24 mi	23 mi	23 mi	21 mi	30 mi	30 mi	30 mi
Sparse	Sparse	Moderate	Moderate	Moderate	Sparse	Sparse	Sparse
None	None	None	None	None	None	None	None
Moderate	Moderate	Severe	Severe	Severe	Substantial		Substantial
None	None	None	None	None	None	None	None
Small	Small	Substantial		None	Substantial		Substantial
Moderate	Moderate	Severe	Severe	Severe	Severe	Severe	Severe
Substantial		Severe	Severe	Severe	Severe	Severe	Severe
Very Poor		Unacceptable		Unacceptable	Unacceptable		Unacceptable
Small	Small	Small	Substantial	Severe	Small	Substantial	Severe
Small	Small	Small	Small	Small	Small	Small	Small
$565	$628	$524	$545		$659	$680	
6½ yr	7 yr	No realistic figure					
Severe	Severe	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Barely acceptable		Not acceptable		Not acceptable	Not acceptable		Not acceptable

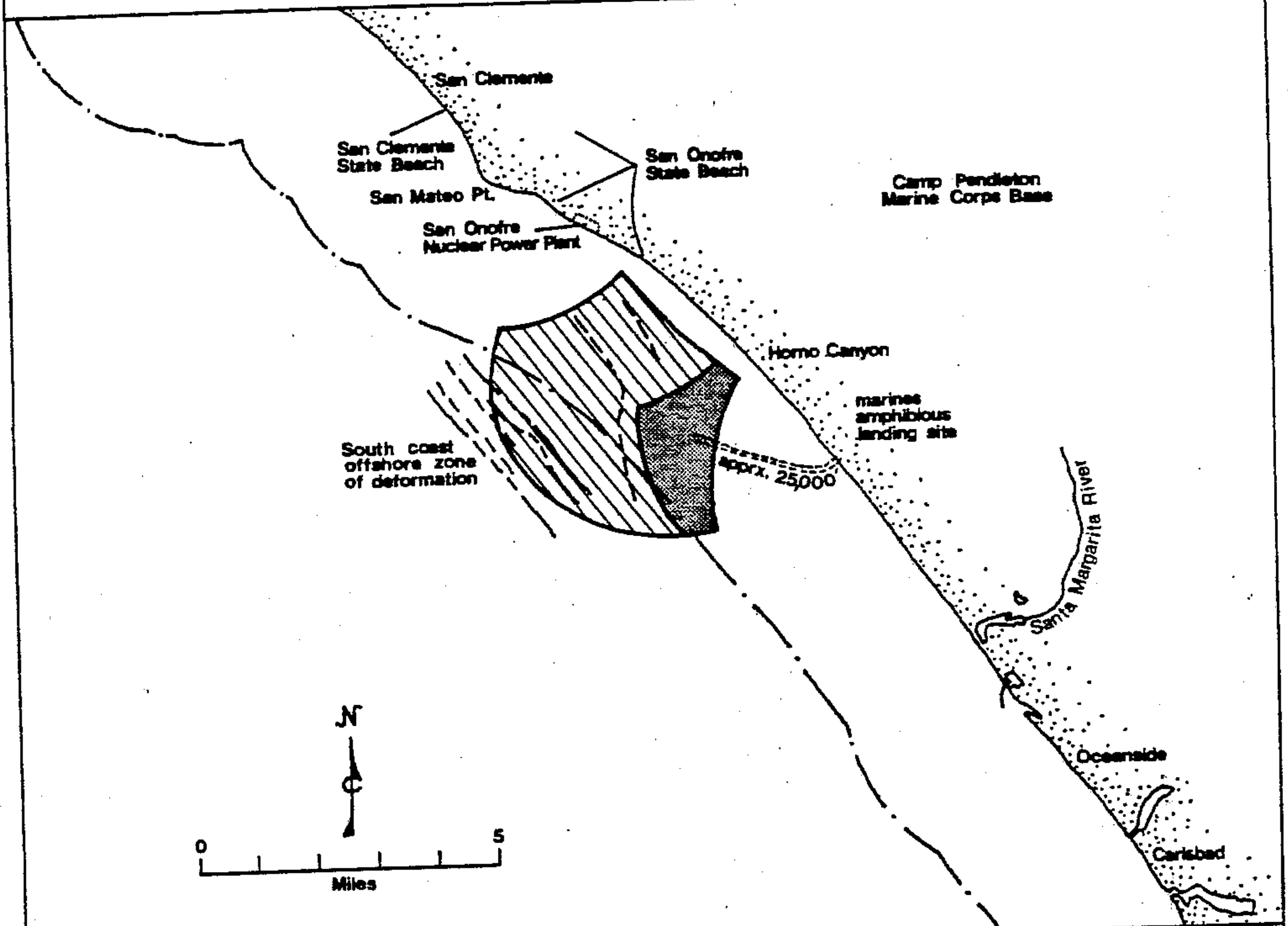
Highway. The advantage of this site is that it is within the three mile limit of State jurisdiction so no new federal legislation would be required to approve such a terminal. But strong opposition to this site would be likely and State approval, requiring both new legislation and application approval, seems highly doubtful. This site should be further considered only if an overwhelming need for LNG is shown and there are no other siting alternatives.

Offshore Camp Pendleton. Both a floating and shallow water bottom-supported type LNG terminal appear feasible off Camp Pendleton (Figure 7), but the geotechnical evaluations which found added traces of possible earthquake faults indicate only medium confidence that the bottom-supported type terminal could be sited there. Public safety problems would be serious since the LNG storage would be offshore and the terminal would be about 7 miles from San Clemente, 4 miles from Marine Corps barracks, and about 4 miles from the San Onofre Nuclear Power Plant. The site area, 1½ to 3 miles offshore, would be visible from San Onofre State Park, Interstate 5, and a long stretch of the San Diego County coast. The site's major advantage, as with the onshore site at Horno Canyon ranked first by the Coastal Commission among four onshore sites, would be the small adverse impact on marine biological resources. This site is less appropriate than Ventura Flats since strong opposition to its use for an LNG terminal could be expected from the U.S. Navy and Marine Corps, which operate amphibious warfare training exercises in the area.

Channel Islands. All the sites on or near the two Santa Barbara Channel Islands, Santa Cruz and Santa Rosa (Figure 8), present severe conflicts with the policies of the California Coastal Act of 1976. The Nature Conservancy is acquiring most of Santa Cruz Island for preservation of the valuable and unique terrestrial and marine life on the lightly disturbed island. All the islands are used by sensitive sea birds and marine mammals whose breeding and living would be seriously impacted by the noise, ship activity, construction activity and other aspects of an LNG terminal even 3 miles from shore. The waters around the islands are designated an Area of Special Biological Significance by the State Water Resources Control Board and are under study for designation as a National Marine Sanctuary. The islands are proposed for national park status. In addition to these serious disadvantages, the Santa Barbara Channel Island sites present severe geotechnical and other engineering problems both for terminal construction and for the required long underwater gas pipeline to shore.

Only a small part of the Off Chinese Harbor site area (Figure 9) just inside 3 miles from the Santa Cruz Island shore can be considered barely acceptable. A floating type terminal appears to be feasible at this site, but it should only be considered if added remoteness from urban areas is required. The site is about 24 miles across the Santa Barbara Channel from Ventura. An underwater gas pipeline from the site to shore would have to be laid from special barges in water as deep as 770 feet. This depth plus possibly unfavorable bottom currents and other conditions could pose serious problems to pipeline construction and reliability.

Offshore Camp Pendleton



Refined Site Zone

Original Site Zone

Pipeline Route

Territorial Seas - 3 mile limit

Fault, dashed where inferred
(from Woodward-Clyde)

Dept. of Fish and Game resource information:
- Sportfishing occurs in the site zone area.
- Brown pelicans are sighted in the area but do not nest locally.
- Least terns nest at the Santa Margarita rivermouth.

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Figure 7

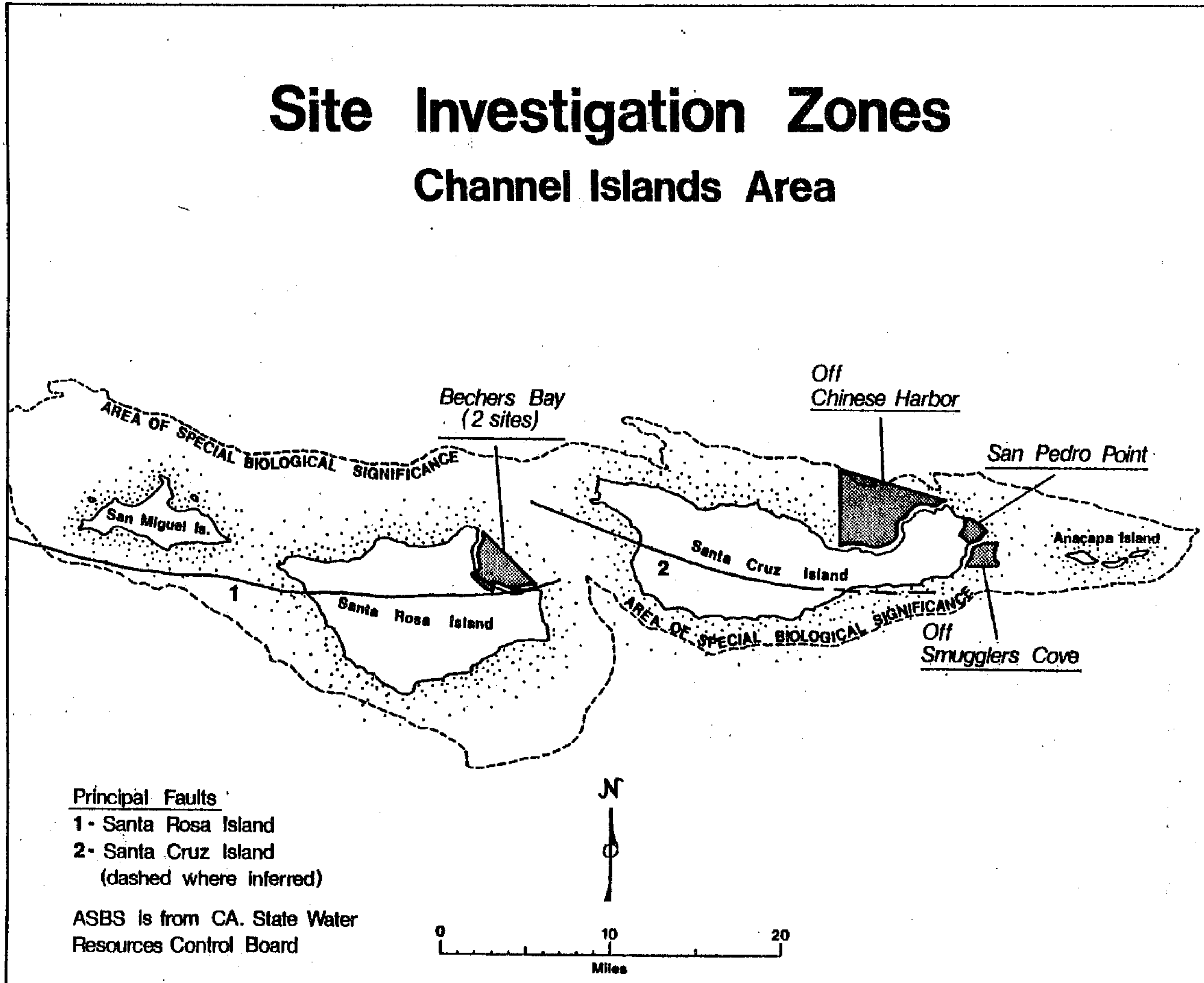
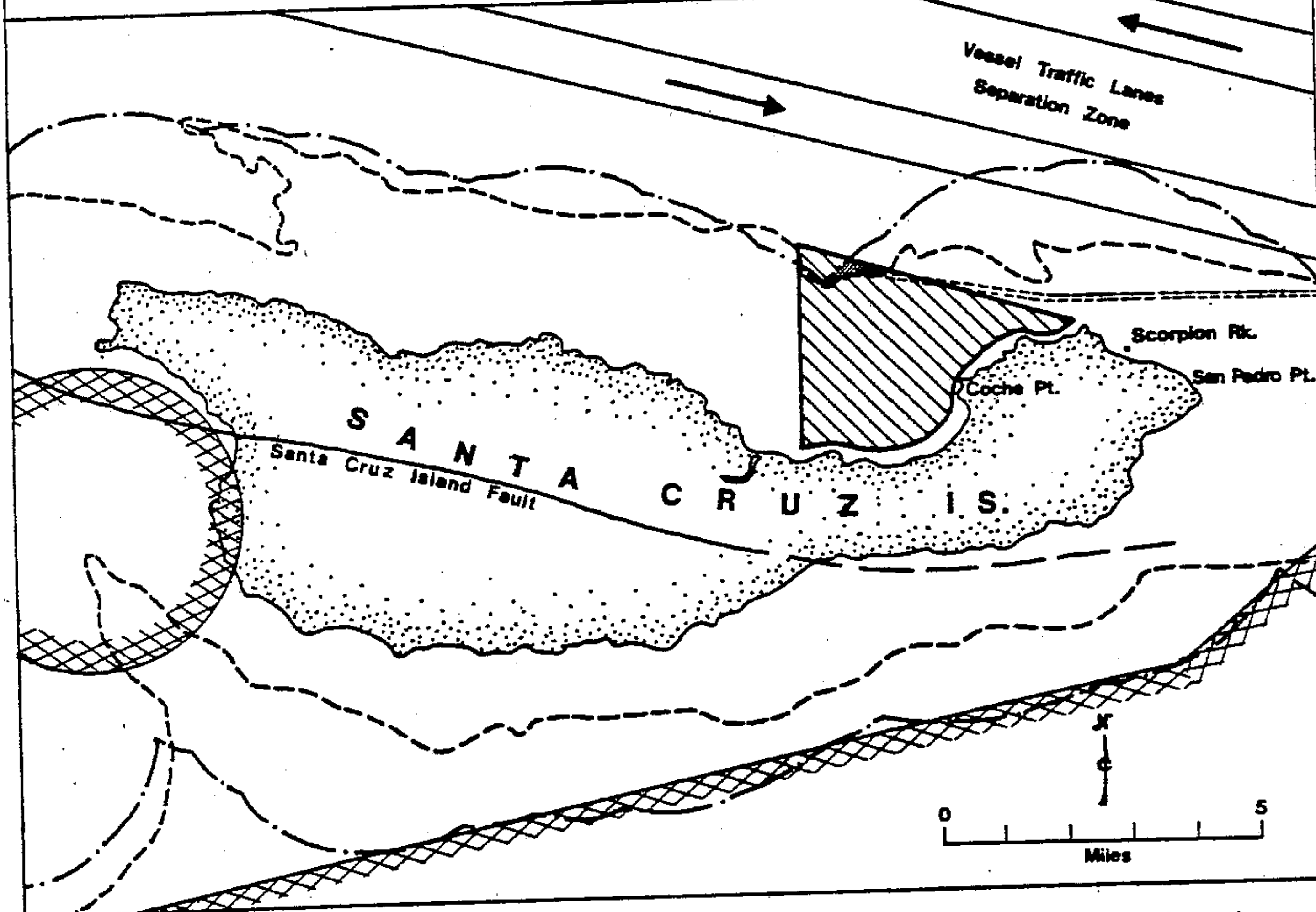

Site Investigation Zones
Channel Islands Area
AREA OF SPECIAL BIOLOGICAL SIGNIFICANCE
Bechers Bay
(2 sites)
Off
Chinese Harbor
San Pedro Point
San Miguel Is.
Santa Rosa Island
Santa Cruz Island
Anacapa Island
1
2
AREA OF SPECIAL BIOLOGICAL SIGNIFICANCE
Off
Smugglers Cove
Principal Faults
1 - Santa Rosa Island
2 - Santa Cruz Island
(dashed where inferred)
ASBS is from CA. State Water Resources Control Board
N
0
10
20
Miles
JVC 6/78

Figure 8

Offshore Chinese Harbor



Refined Site Zone

Original Site Zone

Pipeline Route

Area of Special Biological Significance (seaward boundary - 300 foot isobath)

Territorial Seas - 3 mile limit

Military Operation Area (Pacific Missile Test Center)

Fault, dashed where inferred
(from Woodward-Clyde)

Dept. of Fish and Game resource information:

- Scorpion Rock is the second most important sea-bird colony and supports one of the two brown pelican colonies in the Islands.
- Coche Pt. is a haulout and pupping area for harbor seals.
- Sport and commercial fishing occur within the site zone area.
- The local terrestrial environment supports rare, endangered, and endemic species of plants.

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Figure 9

I. BACKGROUND

A. The Liquefied Natural Gas Terminal Act of 1977

The Liquefied Natural Gas (LNG) Terminal Act of 1977 requires the California Coastal Commission to evaluate potential LNG terminal sites which are offshore from the California mainland, and to submit a final report by September 16, 1978 to the Governor, the Legislature, the Public Utilities Commission (PUC), and the Energy Commission. Section 5650 of the Act states in part:

> " . . . the coastal commission shall complete a final study of potential offshore sites and types of terminals for such sites. Such study shall indicate the most appropriate offshore terminal site or sites, in the coastal commission's judgment, together with the most appropriate type or types of terminals for each such site."

The LNG Terminal Act does not establish a procedure for, or authorize, the granting of a permit to construct and operate an offshore LNG terminal. The Act states that California's first LNG terminal, if permitted by the PUC, shall be on the California mainland. The Coastal Commission recently completed an evaluation and ranking of potential onshore sites and submitted a final report to the PUC, as required by the Act, on May 31, 1978.[1]

During the 1977 legislative deliberations on the LNG Terminal Act, a number of parties raised the possibility that an offshore terminal might have significant advantages over an onshore terminal. The potential advantages cited include decreased safety risks to onshore populations, minimization of conflicts with residential and recreational use of the coast, and decreased adverse environmental impacts. Prior studies had concluded an offshore LNG terminal would be technically feasible but could take a number of years longer to put

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1 Copies of the Final Report Evaluating and Ranking Onshore LNG Terminal Sites, adopted by the Coastal Commission May 24, are available from the Commission's San Francisco office.

into operation than an onshore terminal.[2] There was no time during the deliberations, however, to develop detailed assessments of locating an LNG terminal offshore, and therefore the legislation established a procedure for reaching a decision on a permit for a mainland onshore site by July 31, 1978 and for a Coastal Commission study of offshore alternatives.

The Coastal Commission's final offshore LNG report could be used to guide the siting of a second LNG terminal in California, or, if the PUC determines an LNG terminal is not needed until the late 1980s, to assist selection of the most appropriate site from both onshore and offshore alternatives. In order for California's first LNG terminal to be located offshore, however, the LNG Terminal Act would have to be amended by the Legislature.

B. Description of Possible Offshore Terminal Facilities

Background

While there are many operating onshore LNG receiving terminals throughout the world, and presently two in the United States, no offshore LNG terminals have yet been constructed, except on islands. One terminal is being built on Elba Island in the Savannah River, Georgia, while an LNG receiving terminal is operating on the man-made Canvey Island close to shore in the English Channel. From experience with the existing onshore terminals and similar energy facilities designed primarily for oil development, several possible designs for offshore LNG terminals have been proposed by major engineering companies. These include terminals floating on the water and anchored to the ocean floor and terminals supported by the ocean bottom. Regardless of terminal design, however, any offshore terminal would perform the same function as terminals located onshore: to receive LNG transported by ships, unload and transfer the LNG into storage tanks, regasify it, and deliver natural gas via underwater pipelines to California's gas transmission system. Because cryogenic pipelines able to carry LNG at -260° cannot be built more than a few miles long without serious heat gain problems, an offshore terminal would have to send the regasified LNG to shore as natural gas, so all terminal functions, including LNG storage and regasification, would have to take place at the offshore terminal. With a mainland onshore terminal,

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2 Fairchild Stratos Division, Offshore LNG Receiving Terminal Project, 3 volumes and supplement to volume 2, prepared for Western LNG Terminal Company, Manhattan Beach 1977. Report No. 4-76153. See also:

Atlantis Scientific, Feasibility Study: Offshore Siting of LNG Facilities, 1976.

Marcus, Henry S. and John H. Larson, Offshore Liquefied Natural Gas Terminals, prepared for the U.S. Department of Transportation Center for Transportation Studies, M.I.T., Cambridge, October, 1977.

R and D Associates, Offshore LNG Terminal Study, prepared for Western LNG Terminal Company, Los Angeles, 1976.

the LNG is unloaded from a tanker at the end of a trestle and transferred in a short cryogenic pipeline to storage on land until it is regasified and delivered to the gas transmission system (Figure I-1).

C. LNG Terminal Components and Performance Requirements for This Study

The LNG terminal evaluated here has the same general facilities and performance as the terminal proposed by Western LNG Terminal Associates for the Little Cojo site near Point Conception.

LNG Unloading. Once the LNG tanker has moored beside the terminal, the LNG will be transferred to the terminal's storage tanks. This study has assumed the tanks would have a capacity similar to the onshore terminal proposed by Western LNG Terminal Associates or about 1.65 million barrels. This is approximately equal to the LNG carried by two of the largest existing LNG tankers. The insulated storage tanks will keep the LNG at its normal liquefied temperature of -260^{o}F.

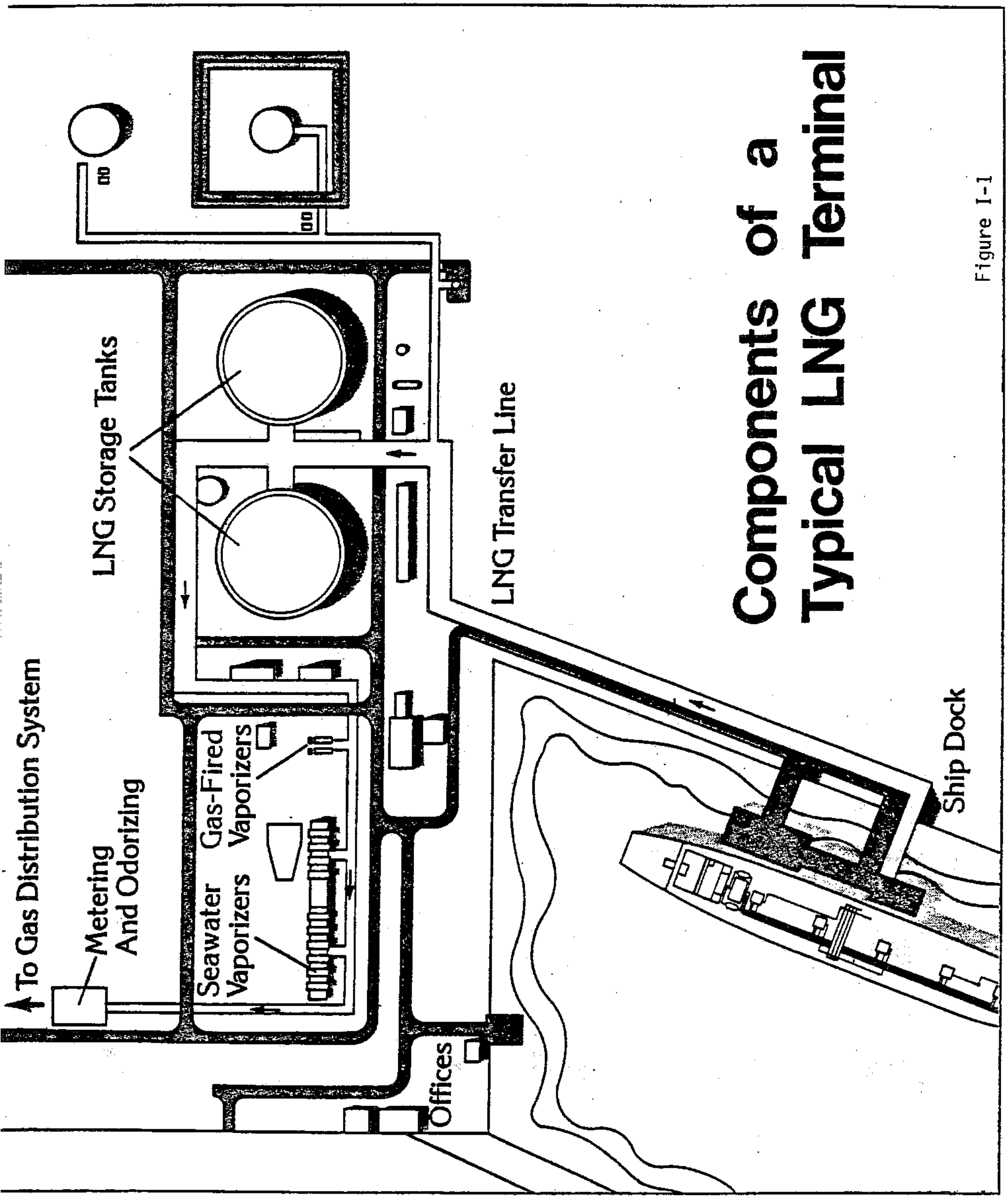
LNG Gasification (Vaporization). Before entering the natural gas transmission system for distribution, the LNG must be gasified and warmed to at least 40^{o}F. The LNG is pumped from the storage tanks and revaporized in a heat exchange chamber using seawater or burning gas as the heat source. Under full operation 1.3 billion cubic feet per day (BCFD) of natural gas will be vaporized.

Seawater System. Seawater to vaporize the LNG is pumped from the ocean at a rate of about 100,000 to 200,000 gallons per minute. After warming the LNG the cooled seawater is returned to the ocean at a temperature about 10^{o} to 12^{o}F lower than at intake. Some form of biocide may be required to prevent marine growth in the seawater system.

Natural Gas Pipeline. Once the LNG has been pressurized, the natural gas is gasified and sent into two parallel underwater natural gas transmission lines. Except where special protection is needed, the pipelines would be on the surface of the ocean floor until they approached the surf zone of the shore, where they would be buried by several feet of cover. The pipelines would remain underground until reaching the most feasible point of connection to California's main gas distribution pipelines. The offshore pipeline distances from evaluated offshore sites vary from 1 to 60 miles, and the onland pipeline distances from shore to the distribution lines vary from 30 to 100 miles.

Bunker C Fuel Oil. Bunker fuel oil for LNG vessels will be brought to the terminal by tanker ship or barge and will be pumped into an oil storage tank. The number of bunker fuel deliveries needed will depend on the capacity of the storage, but approximately four shipments a month are estimated.

Electric Power. Electric power is needed at the terminal to operate the pumps for the seawater system, the LNG unloading process and natural gas send-out, as well as for normal low-voltage power needs. Electricity can be imported by cable to sites near shore or generated by natural gas turbines run with the terminal's vaporized LNG.



Components of a Typical LNG Terminal

Figure I-1

Other Storage. The terminal will store and transfer diesel fuel, fresh water, liquid nitrogen, provisions, and sanitary waste to LNG ships or service barges.

Operating Personnel. The terminal would require an operational work force of 50-75 employees, who will either live in quarters at the facility or commute by boat.

Tug Boats. Arriving LNG tankers will probably require assistance from tugs when making their approach to the terminal. Tugs would probably be based at a mainland California port and steam to the terminal when tankers are due to arrive.

Terminal Design Alternatives

Since no offshore facility has yet been built at an open ocean site, no one design has been universally accepted as the most feasible, reliable or economical. To evaluate and review various possible terminal concepts, the Commission contracted with three terminal design-construction firms for illustrative design work with estimates of construction cost and timing. The three illustrative terminal designs represent the three major structural approaches possible for offshore energy facilities at ocean (not island) sites: floating terminals, bottom-supported terminals in which the storage tanks extend above the water surface, and subsea bottom-supported terminals in which the tanks are completely under water. The final design could combine desirable features of more than one type studied.

D. Previous Commission Actions and Study Approach

In October 1977 the Commission directed the staff to begin an evaluation of possible offshore LNG terminal sites and of different terminal concepts. The basic study approach was to (1) identify major types of offshore LNG terminal designs and their siting requirements; (2) apply those siting requirements to the California offshore area to identify possible suitable siting areas; (3) develop performance standards and criteria for offshore LNG terminals; (4) contract for site-specific illustrative designs of three different types of offshore LNG terminals; (5) evaluate those designs with respect to the standards and criteria; (6) evaluate and judge the remaining suitable siting areas and the types of terminals that could feasibly be placed on them; and (7) assess the time needed for approval of offshore LNG terminals by presenting the site-specific illustrative designs to regulatory agencies for their reactions. This approach and the initial identification of terminal siting requirements and offshore California areas that might be suitable for LNG terminals were presented in the February 1, 1978 staff report, "California Offshore LNG Terminal Study, Interim Report."

To manage and support this special study, the Commission contracted with the consulting firm of Rust and Weinstein, Inc. of San Francisco, with Ted Rust as project manager. The Commission also retained consultants to evaluate the site areas: John J. McMullen Associates in Oxnard for evaluating maritime factors including wind and wave conditions and navigational hazards; Woodward-Clyde Consultants in Orange for geotechnical evaluations; H. J. Degenkolb and Associates for structural engineering analysis; the California Department of Fish and Game for identification of marine and terrestrial plant and wildlife resources; Madrone Associates for analysis of terminal impacts on natural resources; the U.S. Army Corps of Engineers Waterways Experiment Station for wave calculations; and PBQ&D, Inc. for pipeline routes and feasibility; and Alan Magary for editorial consultation. The site conditions are analyzed in Section III, and the supporting consultant reports are summarized in Apendices A through D.

To enable site-specific evaluations of actual LNG terminal designs, the Commission contracted with three design-construction firms for illustrative designs of three different terminal types at three sites. General Dynamics was selected to develop design work for its floating barge terminal concept; Preload-Dravo for its concrete, shallow-water bottom-supported concept; and Norwegian Contractors for its concrete, deep-water bottom-supported concept called "Condeep." These three designs were selected after reviewing proposals from twelve firms. The design studies are evaluated in Section IV and summarized in Appendices G, H, and I.

Since there are no state or federal design standards for offshore LNG terminals, the Commission staff and consultants developed preliminary design criteria, relying heavily on existing standards for other offshore facilities such as ships and oil platforms, but raising the required level of overall safety to one more appropriate for such a large, critical, and potentially hazardous facility. The Commission's consultants in this area, who also helped evaluate the design studies, included Wesson and Associates for safety and fire prevention design criteria; John J. McMullen Associates in New York for maritime and LNG systems criteria; Woodward-Clyde Consultants in Houston for seismic design criteria; PBQ&D, Inc., for critical review of LNG terminal cost studies; Dr. Ben Gerwick, Jr., for structural design criteria; and Maurice V. Scherb for general technical review. These criteria, presented in Appendix F, are recommended as a point of departure for future regulation of LNG terminal design.

The following section presents the terminal and site evaluations and the major conclusions, while Section III provides information and evaluation of the offshore terminal siting zones that were identified in February 1978. Section IV evaluates the three different types of offshore LNG terminals and evaluates their advantages and disadvantages. The regulatory requirements for approval of an offshore LNG terminal at the different sites and the approval prospects, including expected time to terminal operation, are discussed in Section V.

The staff work on this project was done by Brian Baird, Dona Gara, Chris Garland, John Grattan, Bill Johnson, Jody Loeffler, Suzanne Rogalin, Tom Tobin, and Jonathan Van Coops, under the general direction of Energy Coordinator William Ahern.

II. SITE AND TERMINAL EVALUATIONS AND CONCLUSIONS

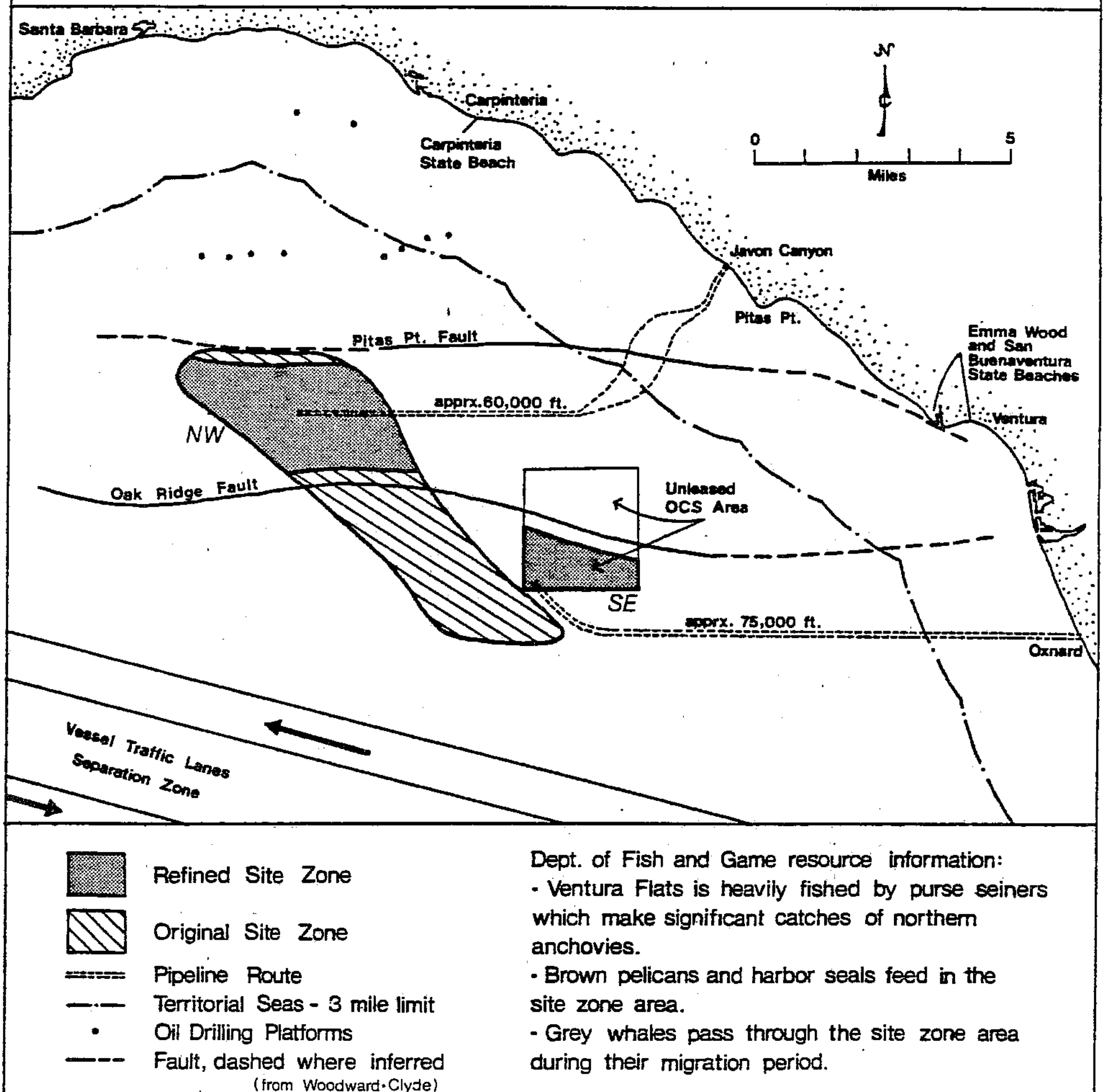
A. Major Conclusions

The most appropriate offshore LNG terminal siting area is the southeast part of the Ventura Flats zone, 12 miles southwest of Ventura in the eastern Santa Barbara Channel, with an underwater pipeline landfall at Oxnard (Figure II-1). A floating type LNG terminal could feasibly be placed in this siting area, but the feasibility of a bottom-supported design there has not been demonstrated. A floating terminal on this site would have small to moderate adverse impacts on marine and coastal resources, but these would be less severe than at any other offshore site investigated by the Coastal Commission. The total construction cost in 1978 dollars of an LNG terminal on southeast Ventura Flats, with connecting subsea and overland pipelines, would cost between $400 and $600 million. If there were strong political, financial and technical support, a terminal there could be in operation in as little as six years from the decision to prepare an application. However, any strong opposition or unforseen technical problems could stretch the approval process many years, since numerous safety, energy, and environmental agencies would have to grant approvals, and both new federal and state legislation would be needed to enable overall terminal approval. The terminal site is on the federally owned outer continental shelf beyond the state's three mile from shore jurisdiction.

Three other siting zones are feasible and acceptable for siting an offshore LNG terminal, but each is substantially less appropriate than Ventura Flats. These three are: 1½-3 miles offshore Camp Pendleton, one mile off Deer Canyon in Ventura County, and approximately three miles offshore Chinese Harbor at Santa Cruz Island (Figure II-2). Other potential siting areas near and on the Santa Barbara Channel Islands are unacceptable. In general, the two zones within three miles of the mainland, off Camp Pendleton and off Deer Canyon, present serious conflicts with recreational and military use of coastal areas. The zones near the Santa Barbara Channel Islands have the substantial disadvantage of being near the valuable and sensitive marine mammal and sea bird breeding areas on these relatively undisturbed islands. They are also difficult to reach with a subsea gas pipeline from shore due to the deep water and severe bottom conditions in the Channel.

The floating type of LNG terminal can be sited at all four acceptable siting zones because its feasibility and approval do not depend strongly on favorable seismic and sea bottom conditions. Only the base of the mooring system for a floating terminal is supported by and attached to the sea bottom (Figure II-2). While this is a critical element of the terminal, it represents only 2% of its cost and can be repaired if damaged by earthquake shaking or subsea landslides or other forces. The floating terminal itself would be supported by the water, and the water surface conditions are generally benign in the site areas that were selected.

Ventura Flats



Dept. of Fish and Game resource information:
- Ventura Flats is heavily fished by purse seiners which make significant catches of northern anchovies.
- Brown pelicans and harbor seals feed in the site zone area.
- Grey whales pass through the site zone area during their migration period.

Figure II-1

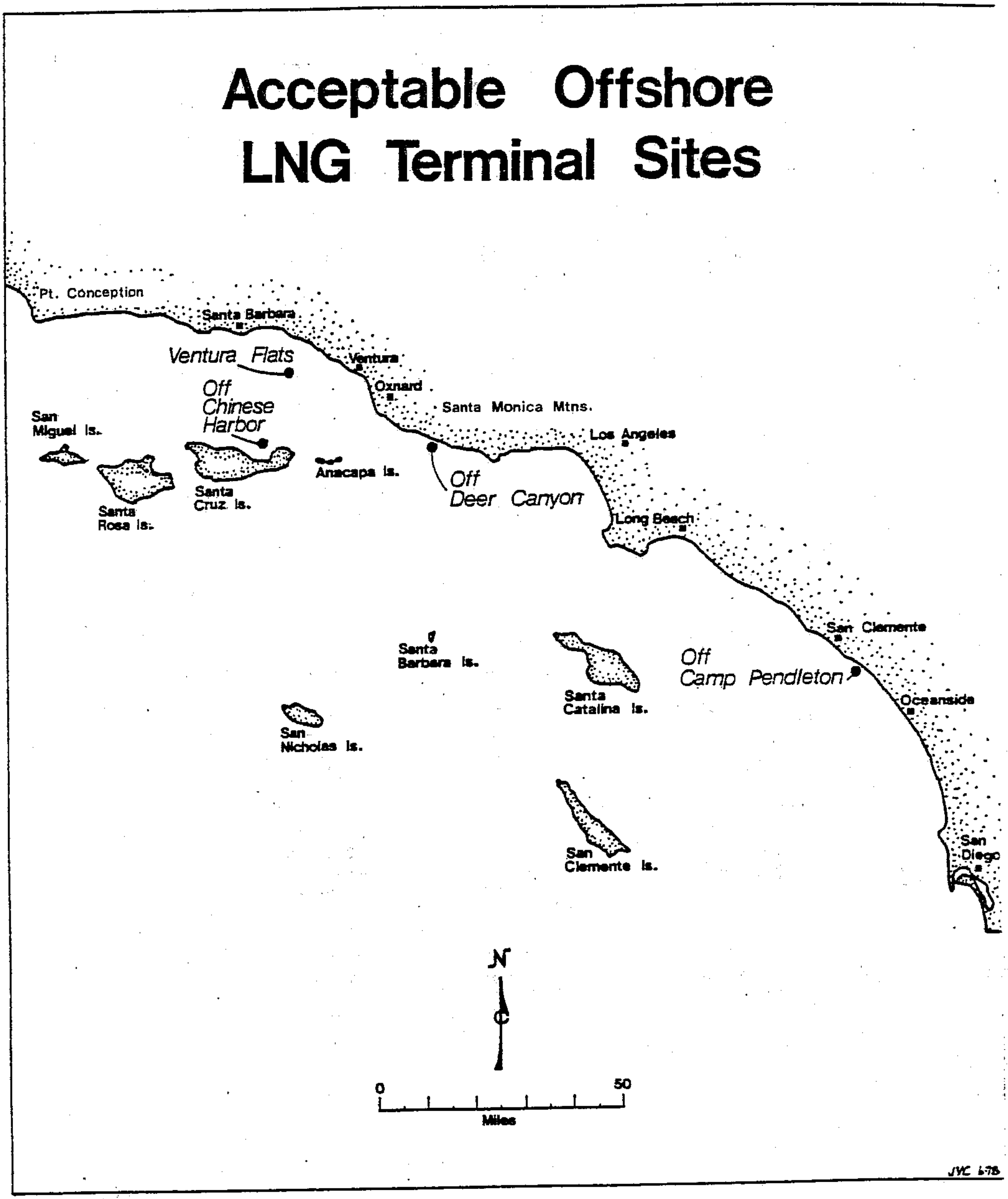

Acceptable Offshore
LNG Terminal Sites
Pt. Conception
Santa Barbara
Ventura Flats
Ventura
Oxnard
Santa Monica Mtns.
Off
Chinese
Harbor
San
Miguel Is.
Santa
Rosa Is.
Santa
Cruz Is.
Anacapa Is.
Off
Deer Canyon
Los Angeles
Long Beach
San Clemente
Santa
Barbara Is.
Off
Camp Pendleton
Santa
Catalina Is.
Oceanside
San
Nicholas Is.
San
Clemente Is.
San
Diego
N
0
50
Miles
JVC 6-78

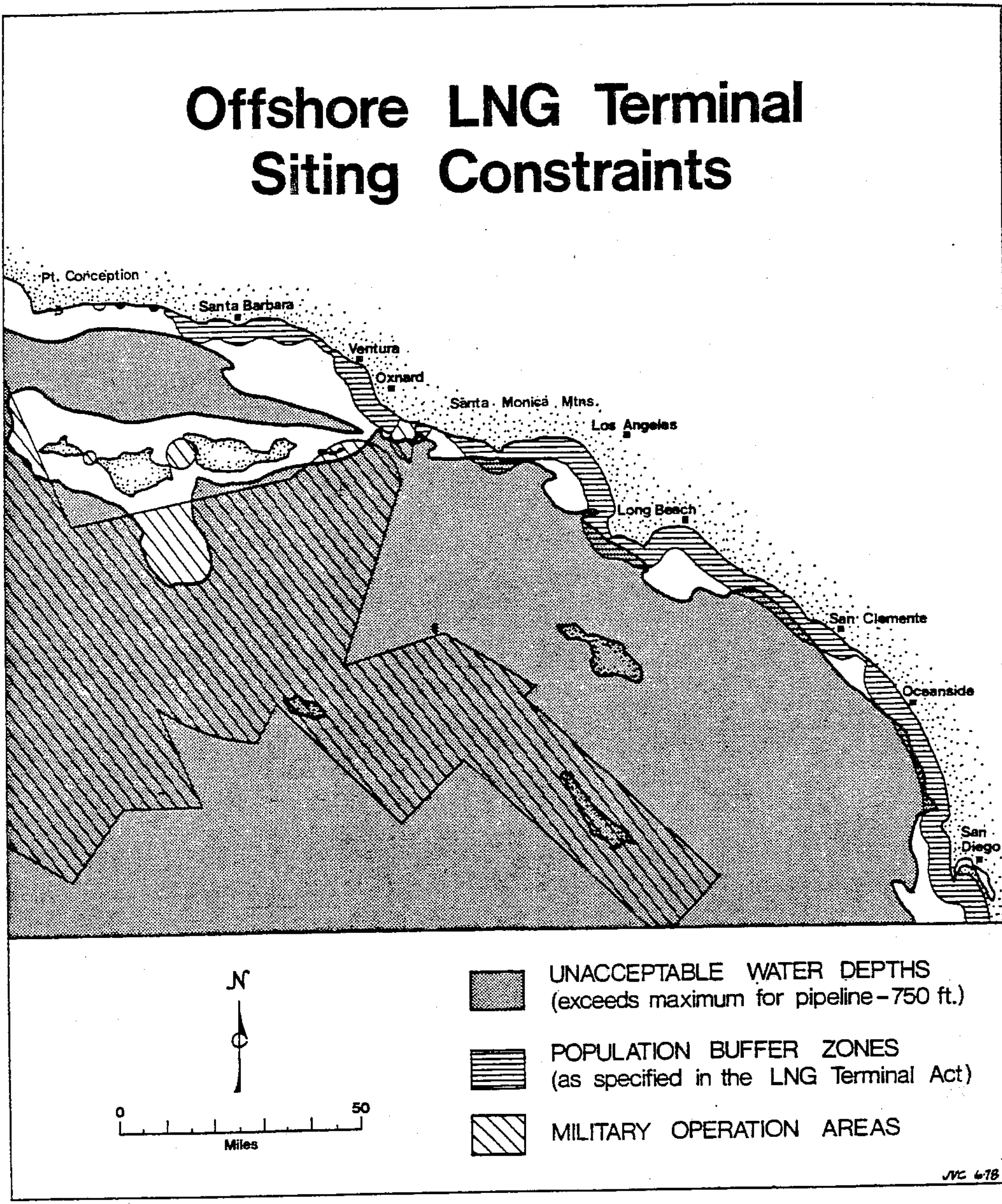
Figure II-2

On the other hand, sea bottom characteristics for supporting large critical facilities off California are generally demanding. The continental shelf is criss-crossed by numerous known and unknown earthquake faults (Figure 5). Much of the sea bottom is steep with unstable slopes. While initial evaluations indicate the shallow water bottom-supported type terminal may be feasible off Camp Pendleton and the deep water bottom-supported type on northwest Ventura Flats and off Chinese Harbor, there would be uncertainty about geotechnical feasibility and regulatory approvals, until an applicant has conducted extensive site and design-specific geotechnical evaluations and carried the burden of proof that a bottom-supported terminal could be safely and reliably built and operated.

The bottom-supported type offshore terminal should not be removed from further consideration, however, because it presents some advantages over the floating type. With floating terminals, both the terminal and the LNG tanker would move in response to wind and waves, creating large relative motions that could make LNG tanker berthing and unloading difficult. In addition, because a floating terminal would experience vertical and horizontal motions in the water, the gas pipeline to the sea bottom would have to swivel. While these motions can be accommodated in floating terminal designs, the bottom-supported type terminal provides a stable unloading berth for tankers and a rigid pipeline connection to the seafloor, enabling greater simplicity and reliability in the terminal system.

B. Initial Site Selection

Selection of feasible sites for an offshore LNG terminal has been just as difficult as locating possible onshore terminal sites. The most difficult siting constraint results from the need to connect any offshore terminal to the mainland with a large, high-pressure gas transmission pipeline. Such a pipeline can be installed reliably in ocean depths only to about 750 feet and, as shown in Figure II-3, this limit prevents use of most waters more than a few miles offshore. It also requires fairly gentle bottom topography. The offshore southern California bathymetry contains many basins as deep as 3,000 feet and much rugged terrain. A second major siting constraint is the generally hostile wind, wave and swell environment at offshore areas north of Point Conception. Wind, waves and fog can be frequent and severe off much of the coast, making marine operations more hazardous and less reliable. Applying the technical constraints of wind and wave conditions, areas offshore central and northern California between Point Conception and the Oregon border were eliminated from serious consideration. In addition, military operations, ship traffic, the presence of valuable marine and coastal resources and other factors limit the number of California offshore areas where a terminal could be built.



Offshore LNG Terminal
Siting Constraints
Pt. Conception
Santa Barbara
Ventura
Oxnard
Santa Monica Mtns.
Los Angeles
Long Beach
San Clemente
Oceanside
San Diego
N
0
50
Miles
UNACCEPTABLE WATER DEPTHS
(exceeds maximum for pipeline-750 ft.)
POPULATION BUFFER ZONES
(as specified in the LNG Terminal Act)
MILITARY OPERATION AREAS
JVC 6-78

Figure II-3

The limitation on ocean depths greater than 750 feet eliminates virtually all of the offshore area more than five miles from the mainland coast, with the exception of the Santa Barbara Channel Islands.[1] The islands are "linked" to the mainland by ocean depths of about 750 feet across the eastern end of the Channel. This connection is present because the Channel Islands are the underwater extension of the onshore Santa Monica Mountains range.

Although the LNG Terminal Act establishes population density requirements for the siting of an onshore LNG terminal to ensure a remote site, no guidance was given on population criteria for possible offshore sites. Siting an offshore facility closer to populated areas than allowed for onshore sites, however, would be inconsistent with legislative intent. Therefore, those offshore areas within four miles of about 1,800 permanent residents or workers were eliminated from consideration.

Military operations pose some potential problems to siting an offshore LNG terminal. Hundreds of square miles immediately south of the Channel Islands and two areas in the island chain are within the critical test ranges of the U.S. Navy's Point Mugu Pacific Missile Test Center. Possible sites off the southern part of the Channel Islands were dropped from serious consideration because of this conflict and the availability of other sites elsewhere around the islands.

As shown in Figure II-4, only a few offshore areas remain as feasible locations after these major siting constraints are applied. Three areas, offshore from Los Angeles, Long Beach and San Diego, were eliminated from further consideration due to the large population concentrations just beyond four miles and the vessel traffic in the area. From the remaining feasible areas, seven site "zones" were selected for extensive review by staff and consultants. Zones, as opposed to specific sites, were chosen to allow for flexibility in future siting after detailed evaluation of bottom conditions, seismic characteristics, possible terminal designs, and other factors. The seven site zones selected were:

Zones	Facility Types Considered
(1) Ventura Flats, eastern Santa Barbara Channel	Floating, Subsea Bottom-Supported
(2) Off Deer Canyon, Ventura County	Floating

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1 Deeper pipelaying techniques are being developed. The same basic siting constraints would apply, however, even if this limit were doubled.

Zones	Facility Types Considered
(3) Off Camp Pendleton San Diego County	Floating, Shallow Bottom-Supported
(4) Smugglers Cove, off Santa Cruz Island	Floating, Shallow Bottom-Supported
(5) San Pedro Point, on Santa Cruz Island	On-island
(6) Chinese Harbor, off Santa Cruz Island	Floating, Shallow and Subsea Bottom-Supported
(7) Bechers Bay, Santa Rosa Island	Floating, Shallow Bottom-Supported, On-island

Parts of the nearshore area off Santa Barbara County, both off Pitas Point and at the western end of the Channel also meet the population and wind and wave requirements. But these offshore sites within three miles of shore were not retained for further evaluation early in this year because there appeared to be at least two feasible onshore sites for an LNG terminal, Little Cojo and Las Varas. There seemed to be no advantage in siting a nearshore terminal in the water where onshore sites were available and appeared more desirable. However, now that seismic problems have eliminated Las Varas and affected approvability of the Little Cojo onshore site, there could be advantages with a floating terminal since it would be decoupled from the most serious seismic forces. On the other hand, any offshore LNG terminal near the mainland in the western Santa Barbara Channel would conflict with the valuable marine and recreational resources present there.

C. Evaluation of Sites and Terminals

The basis for the conclusions is the evaluation of 16 site and terminal type combinations with respect to engineering feasibility, public safety, conflicts with current uses of offshore areas, adverse environmental impacts, cost, and time expected for approvals and construction. In ranking possible onshore LNG terminal sites, the Coastal Commission was required to base its ranking on the policies and goals of the California Coastal Act of 1976. In applying these policies the Commission gave heavy weight to policies protecting public access and recreation along the coast, marine and terrestrial natural resources, and the unique and scenic character of remote coastal areas. The Commission also considered public safety and terminal cost in the ranking. Sites such as the Las Varas site were removed from the ranking when information on seismic

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